

Interacting Effects of Deicing Salt and Drought on Plant Performance and Soil Microbial Function in Stormwater Basins

J.S. Caplan^{1*}, J. Baumgarten¹, K. Opila¹, R. Klinger¹, B. Stone², E. Warburton², G. Simao Slanzon³, N. Nguyen³, and S.W. Eisenman¹

¹ Department of Environmental Design, Temple University, Ambler, PA, USA

² Earth and Biological Sciences Directorate, Pacific Northwest National Laboratory, Richland, WA, USA

³ Department of Tropical Plant and Soil Sciences, University of Hawai'i at Mānoa, Honolulu, HI, USA

*Corresponding author email: jcaplan@temple.edu

Highlights

- Installing highly salt-tolerant vegetation in highway-adjacent basins improved survival, but performance varied widely among taxa.
- Drought and deicing salt interacted to constrain plant physiological function and survival.
- Soil microbial responses were governed more by salt exposure duration than by salinity intensity.

Introduction

In temperate regions, roadway-adjacent stormwater management practices (SMPs) are exposed to winter deicing salt inputs that can affect both vegetation and soil microbial communities. Soil bacteria and fungi strongly influence plant health through nutrient cycling, decomposition, pathogenic activity, and symbiotic relationships, which enhance nutrient uptake and stress tolerance. Understanding how soil microbial communities respond to recurring salt exposure is necessary because these communities regulate many processes that influence plant health and basin function. This study focused on bioinfiltration basins receiving stormwater runoff from I-95 and evaluated plant survival and health, interactions with symbiotic fungi, and soil microbial responses to salinity.

Methodology

Two SMPs adjacent to I-95 in Philadelphia were planted with predominantly salt-tolerant vegetation following reconstruction in late 2022 (Figure 1). Plant survival, growth, chlorophyll status, physiology, and tissue chemistry were monitored from 2023–2025 across contrasting hydrologic and climatic conditions. Root colonization by arbuscular mycorrhizal fungi (AMF) was evaluated for four plant taxa (i.e., types, whether species or cultivars) spanning gradients in stormwater exposure. Colonization frequencies of fungal arbuscules and hyphae (the ratio of which is indicative of the strength of symbiotic nutrient exchange) were quantified with microscopy and related to soil moisture and salinity gradients. A complementary laboratory experiment evaluated how soil microbial communities responded to saline water pulses differing in both salinity and exposure duration using DNA amplicon sequencing of bacterial and fungal communities.

Key Findings

Plant abundance declined from 854 to 537 individuals through the monitoring period, corresponding to approximately 37% mortality. Mortality was greatest during early establishment and varied substantially among taxa. Seaside goldenrod, feather reed grass, pasture rose, and several graminoids (notably common rush) exhibited the strongest overall performance, while other taxa continued to decline through 2025. Physiological measurements indicated that drought was an important stressor: photosynthetic rates declined during the exceptionally hot and dry summer of 2024 but largely recovered in 2025, suggesting resilience among established plants but limited drought tolerance in some taxa.

Leaf chemistry indicated frequent nitrogen and phosphorus limitation, while several metals approached potentially toxic concentrations in some samples. Seaside goldenrod accumulated exceptionally high sodium concentrations while

remaining healthy, suggesting internal sequestration of salt, whereas most other taxa appeared to rely primarily on restricting sodium uptake at the roots.

AMF colonization was widespread across all four plant types studied. However, the ratio of arbuscule to hyphal colonization increased with stormwater exposure despite elevated salinity, suggesting that improved moisture availability promoted stronger nutrient exchange between plants and fungi.

The lab-based microbial experiment demonstrated that exposure duration was a stronger driver of microbial responses than salinity concentration. Short saline pulses generally maintained or increased relative abundances of beneficial bacterial and fungal groups, whereas prolonged exposure suppressed these groups.



Figure 1. Experimental bioinfiltration basin that receives saline stormwater runoff from I-95 in Philadelphia.

Recommendations

These results indicate that successful plant establishment in roadway-adjacent SMPs depends on managing multiple interacting stressors, notably salinity and drought. Plant palettes should prioritize taxa tolerant of both deicing salt exposure and summer drought; although flooding tolerance can also be helpful, periods of soil saturation are typically short. As always, proper installation practices and soil media quality should receive significant attention during the basin construction phase.

Our findings also suggest that SMP designs promoting rapid drainage and limiting prolonged saline exposure may help sustain beneficial microbial communities and plant-fungal symbioses. Together, these results highlight the importance of integrating plant selection, soil ecological function, and hydrologic design in roadway-adjacent stormwater infrastructure.

References

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A Look at Urbanization's Acceleration of Salmon Mortality due to 6PPD-Q and How Green Infrastructure Can Help

E. van Assendelft ¹

¹*Department of Civil and Environmental Engineering, Villanova University, Villanova, PA 19085 (graduate student)*

What I will be presenting:

6PPD-quinone (6PPD-q), a transformation product of the tire rubber preservative 6PPD, has emerged as a toxic aquatic pollutant responsible for rapid mortality in coho salmon across the Puget Sound. Threats from urbanization like 6PPD, compounded with rising temperatures and more severe weather, not only endanger salmon but also jeopardize human health, access to clean drinking water, and recreation. Although green stormwater infrastructure (GSI), such as biofiltration swales or rain gardens, has demonstrated high removal potential for 6PPD-q, widespread implementation is constrained by land availability, maintenance needs, and uncertainty surrounding long-term sorption and degradation. No viable alternative to 6PPD has been implemented, making engineered treatment and source control essential near-term strategies to reduce negative environmental consequences and increase survival chances of coho salmon and other aquatic organisms. The goal of this presentation is to synthesize existing research on 6PPD-q toxicity, evaluate sources of contamination, and investigate solutions to address 6PPD-q concentrations in stormwater runoff.

What the audience will learn:

Attendees will gain a broad understanding of 6PPD-q's history and environmental behavior, including evidence of bioaccumulation, species-specific toxicity, and monitoring approaches used to identify hotspots. The session will highlight which stormwater BMPs show the greatest potential for removal – particularly systems that promote infiltration, sorption, and bioinfiltration. Participants will learn where key knowledge gaps remain, such as degradation pathways and long-term impacts on aquatic species, and how interdisciplinary collaboration can accelerate solutions. Increased funding for research, development of safer tire products, source control via regulations, and implementation of stormwater BMPs are necessary actions that can reduce 6PPD-q exposure across watersheds. Ultimately, the audience will leave with an improved understanding of 6PPD's environmental impact and actionable strategies to reduce contamination, protect salmon populations, and integrate GSI in ways that promote both ecological health and urban green spaces.



Daylighting Tibbetts Brook: Reconnecting a Lost Waterway to Reduce CSOs and Restore Urban Ecology

R. Joshi¹; A. Motzny¹; J. Brennan^{2*}, S. Mehrotra², D. Thompson²

¹New York City Department of Environmental Protection (NYCDEP)

²Hazen and Sawyer

*Corresponding author email: jbrennan@hazenandsawyer.com

What I will be presenting:

This presentation provides an overview of the Tibbetts Brook Daylighting and Greenway Project in the Bronx, New York, a \$150 million initiative to restore a historic waterway while reducing combined sewer overflows (CSOs) to the Harlem River. Historically, Tibbetts Brook flowed from Westchester County through the Bronx to the Harlem River but was diverted into the combined sewer system in the early 1900s following construction of the Putnam Railroad, which constrained the natural floodplain and enabled development within it. This diversion resulted in approximately 5 MGD of dry weather flow being conveyed to the Wards Island Wastewater Resource Recovery Facility, expending energy to treat relatively clean water. During wet weather events, runoff from the 2,100-acre watershed contributes significant peak flows to the system, causing hydraulic capacity constraints, CSO discharges to the Harlem River, and localized street flooding.

Following abandonment of the railroad corridor, New York City evaluated opportunities to restore Tibbetts Brook within the former alignment. The project evolved into a fully integrated design led by NYCDEP and NYC Department of Parks that combines stream daylighting, CSO reduction and public greenway development. The design diverts base and storm flows, up to 24.5 MGD, from Hester and Piero's Mill Pond into a restored open channel through Van Cortlandt Park. Downstream, flows transition to a 2.5-foot-high by 6-foot-wide subsurface conveyance through an active Metropolitan Transportation Authority (MTA) rail yard, navigating major infrastructure including trunk sewers and rail operations while maintaining hydraulic performance and constructability. The system ultimately flows to the Harlem River via an existing outfall. Major outcomes include over 215 million gallons per year of CSO reduction, with construction beginning this year.

What the audience will learn:

Attendees will gain insight into the planning, design, and implementation of a large-scale urban stream daylighting project within a highly constrained corridor. Key takeaways include strategies for integrating stormwater management, ecological restoration, and public space enhancement; approaches to navigating complex vertical and horizontal constraints such as major utility crossings, active rail operations, and limited right-of-way; and lessons learned from multi-agency coordination among DEP, Parks, and other stakeholders. The presentation will illustrate how strategic diversion of both baseflow and stormwater can relieve system capacity constraints while restoring natural hydrologic function. Attendees will also better understand the hydraulic, structural, and constructability considerations required to deliver performance within real-world constraints. These insights can be applied to similar urban watershed restoration projects where legacy infrastructure, competing land uses, and significant constraints are present.

Beyond Traditional Procurement: The Community-Based Partnership Model for Equitable Green Stormwater Infrastructure at Scale

Marco Finazzi^{1*}, Roland Jones¹

¹*Corvias Infrastructure Solutions (CIS), 9475 Lottsford Road, Suite 100, Largo, MD 20774*

^{*}*Corresponding author email: marco.finazzi@cisolutions.com*

What I will be presenting:

As urban areas face the convergence of climate change, aging infrastructure, and growing social inequities, cities urgently need scalable stormwater solutions. Intensifying rainfall increasingly overwhelms drainage systems, often disproportionately impacting underserved communities. Despite broad recognition of the benefits of green stormwater infrastructure (GSI), implementation is constrained by funding gaps, workforce limitations, and rigid contracting models. This presentation introduces the Community-Based Partnership (CBP), a transformative delivery model that aligns public and private capabilities to accelerate GSI deployment while ensuring local economic benefits. We highlight the Clean Water Partnership (CWP) in Prince George's County, MD – the nation's first CBP – which has implemented over \$350 million in projects across 24 municipalities over the past decade. Since 2015, the program has delivered over 200 GSI projects, with 79% of contracts awarded to local, women, and minority-owned businesses (WMBE), and 52% of labor performed by county residents, generating approximately \$655 million in local economic impact. The model has since expanded to multiple regions nationwide, demonstrating its ability to advance stormwater solutions, workforce development, and long-term community resilience.

What the audience will learn:

1. Analyze how the Community-Based Partnership (CBP) model overcomes funding, procurement, and workforce barriers to accelerate large-scale green stormwater infrastructure implementation.
2. Evaluate the measurable economic, workforce, and equity outcomes achieved through the Clean Water Partnership, including WMBE participation, local hiring performance, and documented community economic impact.
3. Explain the structural and contractual differences between the CBP model and traditional public procurement or standard public-private partnership (P3) delivery approaches.
4. Identify key considerations for adapting and replicating the CBP model in other jurisdictions seeking to align infrastructure investment with long-term economic resilience goals.